PALAEONTOLOGICAL HERITAGE REPORT: COMBINED DESKTOP & FIELD-BASED STUDY

SUTHERLAND 2 WIND ENERGY FACILITY AND ASSOCIATED GRID INFRASTRUCTURE NEAR SUTHERLAND, KAROO HOOGLAND MUNICIPALITY (NAMAQUA DISTRICT), NORTHERN CAPE

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EXECUTIVE SUMMARY

Sutherland 2 Wind Farm(Pty) Ltd South Africa is proposing to construct the authorised Sutherland 2 Wind Energy Facility (WEF) (12/12/20/1782/3/AM5), with up to 25 wind turbines and a maximum export capacity of up to 140 MWac, on Farm Portion 1 of Tonteldoosfontein 152, situated on the Roggeveld Plateau near Sutherland, approximately 27 km SSE of Sutherland and 65 km north of Laingsburg. The WEF will be connected by a new 132 kV transmission line (*c*. 20-23 km long) to the on-site substation for the authorized Sutherland WEF or Rietrug WEF, and hence to the National Grid *via* a new Main Transmission Station (MTS) located in the Moordenaars Karoo region *c*. 24 km west of Merweville, Western Cape. The WEF and its associated 132kV Grid Connection will lie within the Namakwa District (Northern Cape Province). The grid connection project was the subject of a separate Basic Assessment (BA) process and subsequently received Environmental Authorisation (EA) from the Department of Forestry Fisheries and the Environment (DFFE) (14/12/16/3/3/1/1814/1 and 14/12/16/3/3/1/1814/2).

The combined project areas for Sutherland Cluster of WEFs is underlain by continental sediments of the Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup) that are known elsewhere to contain import fossil biotas of late Middle Permian age (*Tapinocephalus* Assemblage Zone). These fluvial and lacustrine bedrocks are extensively mantled by Late Caenozoic superficial sediments (colluvium, alluvium, surface gravels, soils *etc*) that are, at most, very sparsely fossiliferous.

Desktop studies - including provisional palaeosensitivity mapping by SAHRIS and the DFFE - as well as several successive palaeontological site visits to the wider region indicate that the Sutherland 2 WEF and Grid Connection Infrastructure project areas are potentially of HIGH palaeosensitivity. However, the recent two-day site visit (30 & 31 September 2022), as well as previous field-based assessments of the central and eastern sectors of the Grid Connection corridor by Almond (2017a, 2017b, 2019, 2021c, 20921d, 2022), indicate that *scientifically valuable, conservation-worthy* fossil remains have a very sparse and largely unpredictable distribution here. **All of the handful of newly recorded fossil sites within the WEF and Grid Connection project areas are of limited scientific or conservation value** (see Provisional Field Rating tabulated in Appendix 1 as well as previous PIA reports by Almond in the References), while **no significant known fossil sites lie within or close to (< 20 m) the relevant development footprints** (see satellite maps in Appendix 1, Figs. A1.1, A1.2).

Anticipated impacts on fossil heritage resources of the proposed renewable energy developments (WEF, Grid Connection) in the **Construction Phase** will have a NEGATIVE MEDIUM significance without mitigation, decreasing to NEGATIVE LOW following full implementation of the proposed mitigation measures. Negative residual impacts during the construction phase will be partially offset by an improved palaeontological data base and fossil collections due to mitigation (*positive* impacts). Confidence levels for this assessment are Medium, given the number of previous field-based PIA studies in the broader project area. Once constructed,

the **Operational and De-commissioning Phases** of the WEF and grid connection infrastructure developments will not involve further adverse impacts on palaeontological heritage, so these are not assessed here.

The cumulative impact significance of each of the proposed WEF and grid connection projects in the context of other proposed or authorised renewable energy developments in the region is NEGATIVE MEDIUM without mitigation. This would fall to *NEGATIVE LOW provided that* the proposed monitoring and mitigation recommendations made for *all* these various renewable energy projects are consistently and fully implemented. The anticipated cumulative impacts fall within acceptable limits.

For these reasons, there are no palaeontological heritage reservations concerning the proposed final layouts for the Sutherland 2 WEF and associated Grid Connection Infrastructure (including the on-site substation) (*i.e.* layouts are acceptable from palaeontological perspective) and no mitigation regarding the recorded fossil sites - including micro-siting of the proposed final layouts – is recommended here.

- **Input into the EMPrs**

Given the very large project areas concerned, the substantial number of fossil sites now recorded in the wider region as well as the inherent unpredictability of these sites, the potential occurrence of additional *unrecorded* sites of scientific and conservation value at or beneath the ground surface within the WEF and grid connection development footprints cannot be completely excluded.

It is therefore recommended that:

(1) The final authorised layouts of the WEF and its associated grid connection infrastructure should be cross-checked against the known available palaeontological database. Residual, potentially sensitive, un-surveyed sectors of the western sector of the grid connection footprint – notably *those* between the Sutherland 2 WEF on-site substation and Sutherland / Rietrug WEF on-site substations - may need to be surveyed prior to commencement of clearing activities by a professional palaeontologist, with recording and judicious sampling or collection of any scientifically valuable fossil material.

(2) New fossil material encountered or exposed during the Construction Phase is best handled through the Chance Fossil Finds Protocol outlined in Appendix 2. This tabulated protocol should be incorporated into the EMPr for each development and fully implemented by the responsible Environmental Control Officer (ECO) / Environmental Site Officer (ESO).

The ECO / ESO responsible for the WEF and Grid Connection Infrastructure developments should be made aware of the possibility of important fossil remains (vertebrate bones, teeth and burrows, petrified wood, plant-rich horizons *etc.*) being found or unearthed during the construction phase of the projects. Monitoring for fossil material of all major surface clearance (including access roads) and deeper (>1m) excavations by the ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds should be safeguarded, preferably *in situ*, and reported at the earliest opportunity to the South African Heritage Resources Agency (SAHRA) for recording and sampling by a professional palaeontologist. If triggered, these mitigation actions to conserve legally-protected fossil heritage are considered to be essential.

(3) The palaeontologist will be required to apply for a Fossil Collection Permit from SAHRA for professional mitigation in the Northern Cape. All fieldwork and reporting should meet the standards of international best practice as well as those developed for PIA reports by SAHRA (2013). Fossil material collected must be safeguarded and curated within an approved palaeontological repository (*e.g.* museum or university collection) with full collection data.

1. PROJECT DESCRIPTION AND BRIEF

Sutherland 2 Wind Farm Pty) Ltd South Africa is proposing to construct a wind energy facility (WEF), known as the Sutherland 2 WEF, with up to 25 wind turbines and a maximum export capacity of 140 MWac. The development will be located on Farm Portion 1 of Tonteldoosfontein 152, situated on the Roggeveld Plateau near Sutherland, approximately 27 km SSE of Sutherland and 65 km north of Laingsburg, within the Namakwa District Municipality and the Karoo Hoogland Local Municipality, Northern Cape Province (Figures 1 & 2).

Associated WEF infrastructure includes wind turbines, an internal road network, on-site substations, powerlines, laydown areas and offices. The WEF will be connected by a new 132 kV transmission line (*c*. 20-23 km long) to the on-site substation for the authorized Sutherland WEF or Rietrug WEF, and hence to the National Grid *via* a new Main Transmission Station (MTS) located in the Moordenaars Karoo region *c*. 24 km west of Merweville, Western Cape.

For the purposes of this walkthrough report, the 132kV grid connection has been included up to its turn-in point to the Sutherland WEF site. As the proposed grid connection for the Sutherland 2 WEF has been authorised (14/12/16/3/3/1/1814/1 and 14/12/16/3/3/1/1814/2) and the EMPrs approved, this has been included within the walkthrough report for completeness.

1.1. WEF project description

The proposed Sutherland 2 WEF will include the following:

- Up to 25 wind turbines (140MW maximum export capacity), with a hub height up to of 200m and rotor diameter up to 200m;
- The wind turbines will be connected to another by means of medium voltage cables;
- An internal gravel road network will be constructed to facilitate movement between turbines on site. These roads will include drainage and cabling;
- A hardstanding laydown area of a maximum of 10 000m^2 will be constructed; and
- A temporary site office will be constructed on site for all contractors. This would be approximately 5000m^2 in size.

The proposed IPP portion of the on-site substation and associated infrastructure includes the following:

- An IPP portion of the on-site substation;
- Laydown area;
- Operation & Maintenance Building;
- Fencing of the proposed on-site substation;
- Battery Energy Storage Infrastructure (BESS).

The proposed Switching Station portion of the on-site substation and powerline will include the following:

- Switching Station portion of the on-site substation:
- Fencing;
- 132kV distribution line from the proposed Sutherland 2 WEF on-site substation to the Acrux third party substation (including tower/pylon infrastructure and foundations);
- Connection to the Acrux third party substation; and
- Service road below the powerline.

The property affected by the 140MW Sutherland 2 WEF and associated infrastructure includes the following:

- Portion 1 of Tonteldoosfontein Farm 152

The properties associated with grid connection infrastructure include the following:

- Portion 1 of Tonteldoosfontein Farm 152;
- Portion 2 of Gunsfontein Farm 151;
- Portion 1 of Gunsfontein 151;
- Portion 1 of Beeren Valley Farm 150;
- Remaining Extent of Beeren Valley Farm 150; and
- Remaining Extent of Nooitgedacht Farm 148.

Sutherland 2 Wind Farm (Pty) Ltd received EA (DFFE Ref: 12/12/20/1782/3), dated 10 November 2016 and further amendments to the EA dated 25 November 2016, 25 August 2017, 10 March 2020, 08 June 2020 and the latest 09 July 2021, for the development of the 140MW Sutherland 2 Wind Energy Facility (WEF) and associated infrastructure, in the Northern Cape Province. The WEF received an EA for the Independent Power Producer (IPP) portion of the on-site substation (DFFE Ref: 14/12/16/3/3/1/1814/1) on 20 October 2021 and received a separate EA for Switching Station portion of the on-site substation and 132kV overhead powerline (DFFE Ref: 14/12/16/3/3/1/1814/2) on 20 October 2021. The Environmental Management Programmes (EMPrs) for the WEF, IPP portion of the on-site substation and Eskom portion of the on-site substation, including the 132kV overhead powerline, has been approved by the DFFE, and will therefore be included within the Final Layout for the WEF for completeness.

The Sutherland 2 WEF has been selected as a Preferred Bidder project *via* a private off-taker and construction is expected to commence in early 2023. Sutherland 2 Wind Farm (Pty) Ltd has commissioned Nala Environmental (Pty) Ltd to undertake the ground truthing and subsequent finalisation of the layouts and EMPrs, in terms of the NEMA EIA Regulations, 2014 (as amended). As per the conditions of the EA, independent specialist walkthrough's have been undertaken to inform the final layout and final EMPr for the wind energy facility and associated infrastructure.

Palaeontological desktop studies - including provisional palaeosensitivity mapping by SAHRIS and the DFFE - as well as several successive palaeontological site visits to the region indicate that the Sutherland 2 WEF and Grid Connection Infrastructure project areas are potentially of HIGH to VERY HIGH palaeosensitivity. SAHRA has noted that the original EA Application for the original over-arching Sutherland Renewable Energy Facility in 2012 was never submitted to SAHRA, and therefore no comments were issued. SAHRA therefore required that the final layout of the WEF facilities be palaeontologically surveyed and a report submitted to SAHRA prior to construction (SAHRA Interim Comment 16 January 2016, Case ID 10498, 15 May 2017; SAHRA Final Comment December 2 2019, Case ID 14521). Combined field-based palaeontological assessment reports for the Sutherland WEF and Rietrug WEF, together with their respective grid connections to the new MTS near Merweville, have subsequently been submitted to SAHRA in 2022 (Almond 2022 and references therein).

The present report provides a combined desktop and field-based assessment of the authorised Sutherland 2 WEF and its associated 132 kV grid connection. Sectors of the grid connection from the Sutherland Cluster WEF on-site substations up to and including the new MTS near Merweville (in part falling within the Western Cape Province) have already been assessed (Almond 2017a, 2017b, 2019, 2021c, 2021d, 2022). They will not be treated in detail in this report, while the results of these previous assessments are taken into account for the purposes of the present WEF and grid connection assessment report.

This PIA report has been commissioned on behalf of the proponent by the independent EAP, Nala Environmental Consultants (Contact details: Ms Arlene Singh of Nala Environmental Consultants. Corner of Old Pretoria Main Road & Maxwell Drive, Waterfall, Johannesburg, 2090.Tel: +27 84 277 7074. E-mail: Arlene@veersgroup.com). It will contribute to the pre-construction heritage evaluation ("heritage walkdown") of the Sutherland 2 WEF and grid connection final layouts, as well as to the respective EMPrs for the proposed renewable energy developments.

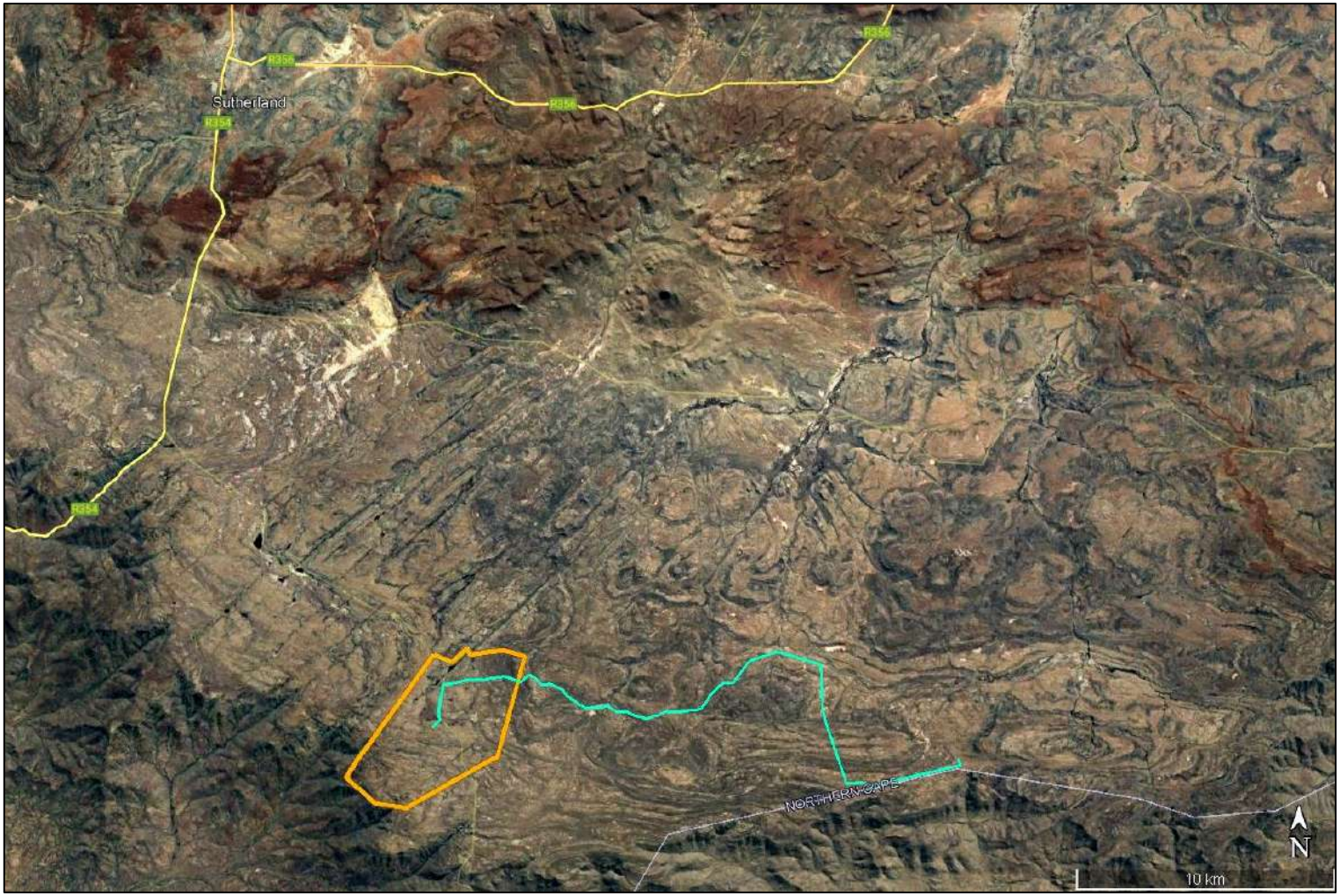

Figure 1: Google Earth © satellite map showing the location of the authorized Sutherland 2 WEF project area on the Roggeveld Plateau *c*. 27 km SSE of Sutherland (orange polygon) and its associated Grid Connection (green line). The combined project area lies entirely within the Northern Cape Province.

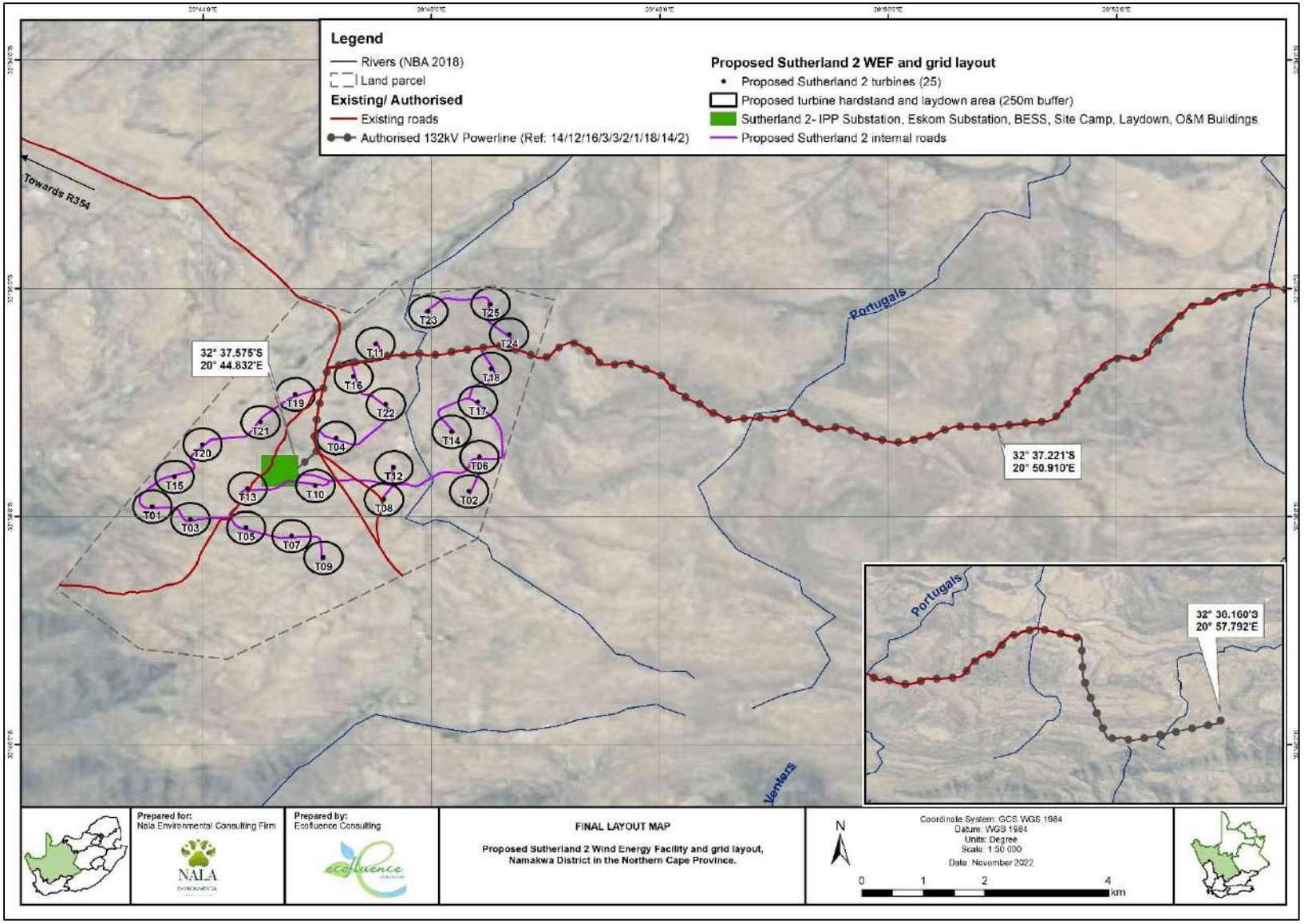

Figure 2: Final layout of the Sutherland 2 WEF.

2. DATA SOURCES & METHODOLOGY

This study evaluates the implications for palaeontological heritage resources posed by the proposed final layouts of the authorized Mainstream Sutherland 2 WEF near Sutherland, together with its associated Grid Connection, within the Northern Cape, as shown in map Figures 1 and 2 as well as satellite images (See Figure A1.1 in Appendix 1). It will also inform the EMPr for this renewable energy project.

This development falls under Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance
- palaeontological sites
- palaeontological objects and material, meteorites and rare geological specimens

The desktop and field-based palaeontological heritage study of the Sutherland 2 WEF and Grid Connection Infrastructure project areas was based on the following information resources:

1. A short project outline, kmz files and maps provided by Nala Environmental Consultants;
2. A desktop review of:
(a) the relevant 1:50 000 scale topographic maps (322DA Verlatekloof, 3220DB Komsberg) as well as the 1:250 000 scale topographic map 3220 Sutherland;
(b) Google Earth© satellite imagery;
(c) published geological and palaeontological literature, including 1:250 000 geological and metallogenic maps 3220 Sutherland and accompanying sheet explanations (Theron 1983, Cole & Vorster 1999) as well as
(d) several previous fossil heritage assessments (PIAs) in the Sutherland – Merweville region by the author listed in the References (especially Almond 2017a, 2017b, 2019, 2021a-d, 2022 which relate directly to the Sutherland Cluster WEFs and their grid connections and access roads).
3. The author's field experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008 and PIA reports listed in the References); and
4. An 2-day field assessment of the Sutherland 2 WEF project area as well as a drive-down of farm roads within close proximity to the grid connection corridor on Farm Gunstfontein 151, situated between the Sutherland 2 and Rietrug WEF project areas by the author and an experienced field assistant (Ms Madelon Tusenius, *Natura Viva* cc, Cape Town), during the period 30 to 31 September 2022 (*N.B.* Access to Gunstfontein 151 itself was not available). Land parcels traversed by the eastern sector of the grid connection corridor within the Sutherland WEF and Rietrug WEF project areas have already been assessed by Almond (2022 and PIA references therein).

Following an initial desktop study based on the resources listed above as well as identification of potentially sensitive bedrock exposures (especially mudrocks) using Google Earth© satellite imagery, the palaeontological site visit involved the examination of representative exposures of bedrock units and superficial sediments within and within close proximity to the Sutherland 2 WEF project area, including portions – but *not* all - of the proposed final footprints (*N.B.* most sectors of the project footprints are mantled in palaeontologically insensitive superficial deposits). The primary focus was on mudrock exposures with well-developed palaeosol horizons marked by pedogenic calcrete concretions. This study was undertaken in order (1) to evaluate the palaeontological heritage implications of the proposed WEF and grid connection layouts on local fossil heritage resources and (2) the need, if any, for further palaeontological input, monitoring or mitigation during the final layout design, pre-construction or construction phases of the WEF and grid connection developments. Approximately 50 potentially fossiliferous exposures of Karoo Supergroup bedrocks and Late Caenozoic superficial

sediments were examined, with recording of key sedimentary and other geological features of scientific interest as well as of any fossil finds (See Sections 5 and 6 of this report and data table, satellite maps provided in Appendix 1).

3. ASSUMPTIONS & LIMITATIONS

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:
(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium *etc*).
Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist.

Palaeontological surveys in the Roggeveld Plateau region are generally constrained by bedrock exposure levels due to widespread cover by Late Caenozoic superficial sediments and karroid vegetation. However, several good bedrock exposures - including mudrock facies that were the primary target for palaeontological surveying - are available in the present study area. Due to inevitable time limitations and the large project areas involved, it was not possible to pay much attention to extensive sandstone outcrop areas, although these may also yield sporadic, scientifically valuable fossil material

in the Abrahamskraal Formation outcrop area. Access to potentially fossiliferous exposures on Gunstfontein 151 was not available at the time of the field study. Nevertheless, given the team's extensive experience of palaeontological heritage in the Roggeveld region, confidence levels for the present PIA report are rated as Medium.

The season in which the site visit took place has no critical bearing on the palaeontological study, although palaeontological fieldwork in the Upper Karoo during September was very uncomfortable, given the very cold temperatures and persistent high winds.

4. LEGISLATIVE CONTEXT

The present combined desktop and field-based palaeontological heritage report for the Sutherland WEF Cluster developments falls under Sections 35 and 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), and it will also inform the EMPrs for these two renewable energy projects. The responsible Provincial Heritage Resources Agencies for the Northern and Western Cape are SAHRA and HWC respectively.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:
(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by SAHRA (2013) and by Heritage Western Cape (2021).

5. GEOLOGICAL CONTEXT

This section of the report focusses on the geology of the Sutherland 2 WEF and the grid connection corridor sector linking this with the previously assessed Sutherland WEF and Rietrug WEF project areas on the Roggeveld Plateau (*cf* Almond 2022). The geological context for the associated grid connections, MTS site and access road from the R354 has already been treated in some detail in the relevant, extensively illustrated PIA reports by the author (*e.g.* Almond 2017a, 2017b, 2019, 2021d, 2022).

The Sutherland 2 WEF and western grid connection project area comprises, for the most part, low relief, gently undulating, rocky to sandy and gravelly terrain towards the steep escarpment bordering the Roggeveld Plateau at elevations between approximately 1560 and 1656 m amsl. (Liebensbergkom 1656 m amsl.). Low ridges and outcrops of bare to bouldery sandstone and colluvial to eluvial surface gravels are vegetated by sparse to dense, low karroid shrubby vegetation and grasses (*cf* Figs. 6 to 10). The area is traversed by comparatively few drainage lines. A network of streams on Gunstfontein 151 feeds north-eastwards into the Portugalsrivier. A pronounced, deeply-incised, steep-sided, NE-SE trending trough passing Theronsrus farmstead is related to radial fracturing associated with Late Cretaceous Sutherland Suite igneous activity.

The geology of the Roggeveld region to the SSE of Sutherland is outlined on the 1: 250 000 scale geology sheet 3220 Sutherland (Theron 1983) (Fig. 4, blue polygon) as well as on the updated 1: 250 000 Sutherland metallogenic map that includes important new stratigraphic detail for the Lower Beaufort Group succession (Cole & Vorster 1999) (Fig. 5). The Sutherland 2 WEF project area is entirely underlain by Middle Permian continental sediments of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup), and in particular the **Abrahamskraal Formation** (Pa) at the base of the Lower Beaufort Group succession (Johnson *et al.* 2006, Day & Rubidge 2014, Cole *et al.* 2016). According to the most recent geological mapping, the WEF and western grid connection project areas are almost entirely underlain by the sandstone-dominated **Moordenaars Member** situated towards the top of the Abrahamskraal succession (See stratigraphic column in Fig. 3). Igneous rocks of the Karoo Dolerite Suite and Sutherland Suite are not mapped within the project area. The Beaufort Group bedrocks within the study area are extensively overlain by unconsolidated Late Caenozoic **superficial deposits** which are largely unfossiliferous and are accordingly not an important focus for the present palaeontological study.

The geology of the various sedimentary rock units represented in this portion of the Roggeveld Plateau have been described and illustrated, with extensive references, in several previous PIA reports by the author (*cf* Almond 2017, 2019, 2021a-d, 2022), to which the interested reader is directed. Representative exposures of the main sedimentary rock units encountered within, as well as on the periphery of, the Sutherland 2 WEF and western grid connection project areas (Farm Gunstfontein 151) are illustrated below in Figures 6 to 33, together with explanatory figure legends.

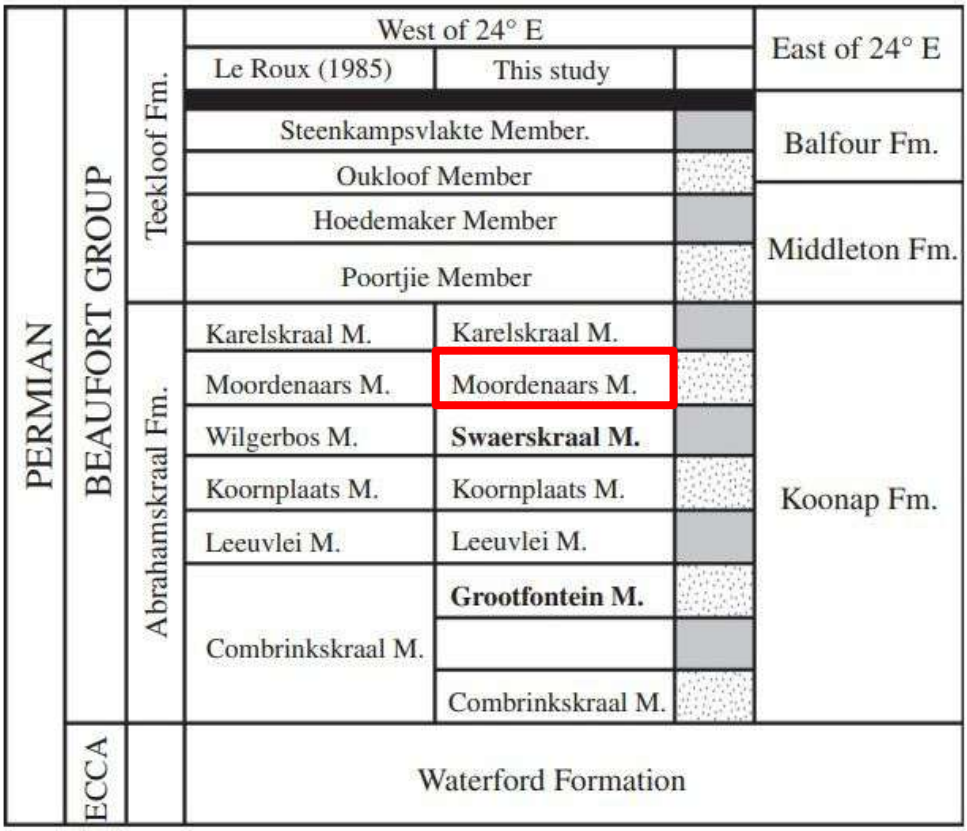

Figure 3: Revised lithostratigraphy of the Abrahamskraal Formation (Lower Beaufort Group) from Day & Rubidge (2014). The Moordenaars Member represented within the Sutherland 2 WEF and western sector of Grid Connection Infrastruture project areas on the Roggeveld Plateau is outlined in red. Older members of the Abrahamskraal Formation are also represented within the more eastern sectors of the grid connection project area (*cf* Almond 2017a, 2019, 2021d, 2022).

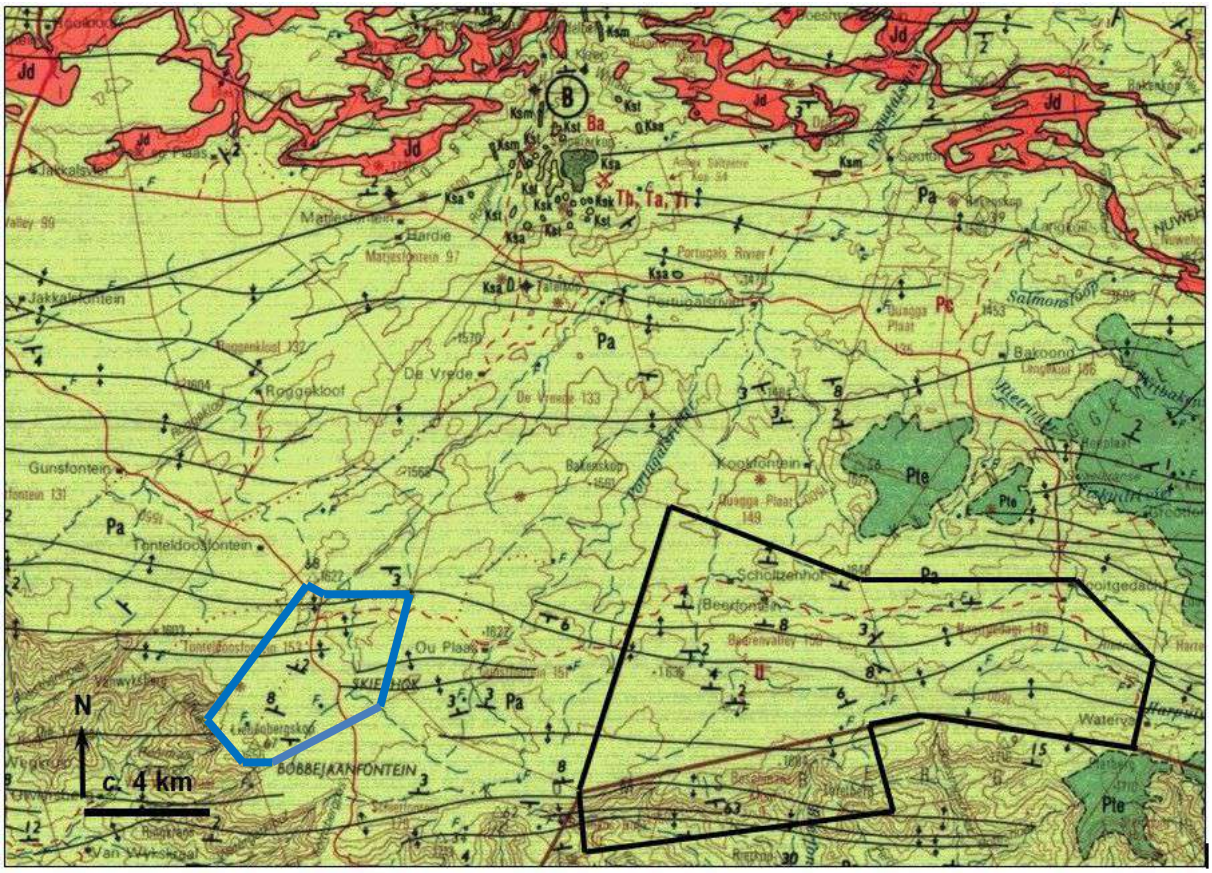

Figure 4: Extract from 1: 250 000 geological sheet 3220 Sutherland (Council for Geoscience, Pretoria) showing the *approximate* outline of the authorised Sutherland 2 WEF project area on Portion 1 of Tonteldoosfontein 152 (blue polygon) as well as the previously assessed project areas for the authorised Farm Sutherland WEF and Rietrug Cluster combined project area (black polygon) in the Roggeveld Plateau region to the north of and along the Roggeveld Escarpment, some 40 km southeast of Sutherland, Northern and Western Cape. No historical fossil sites are mapped here. The corridor for the propose 132 kV transmission line linking the Sutherland 2 on-site substation with on-site substations for the Sutherland and / or Rietrug WEFs largely follows the existing farm road (red dashed line) between these project areas (See Figures 1 & 2 above).

The main bedrock units represented in the broader study region include:
Pa (pale green) = Abrahamskraal Formation (Lower Beaufort Group) – Swaerskraal, Moordenarskaroo and Karelskraal Members (only the Mordenaarskaroo Member is represented within the Sutherland 2 WEF project area itself)
Pte (dark green) = Teekloof Formation (Lower Beaufort Group) – Poortjie Member
Jd (red) = Karoo Dolerite Suite (Early Jurassic)
Ksa (green) – Sutherland Suite igneous intrusions and volcanics (Late Cretaceous)

***N.B.* Late Caenozoic superficial deposits that are not mapped at 1: 250 000 scale also occur here, including alluvium, colluvium, surface gravels, pan sediments, soils and calcrete.**

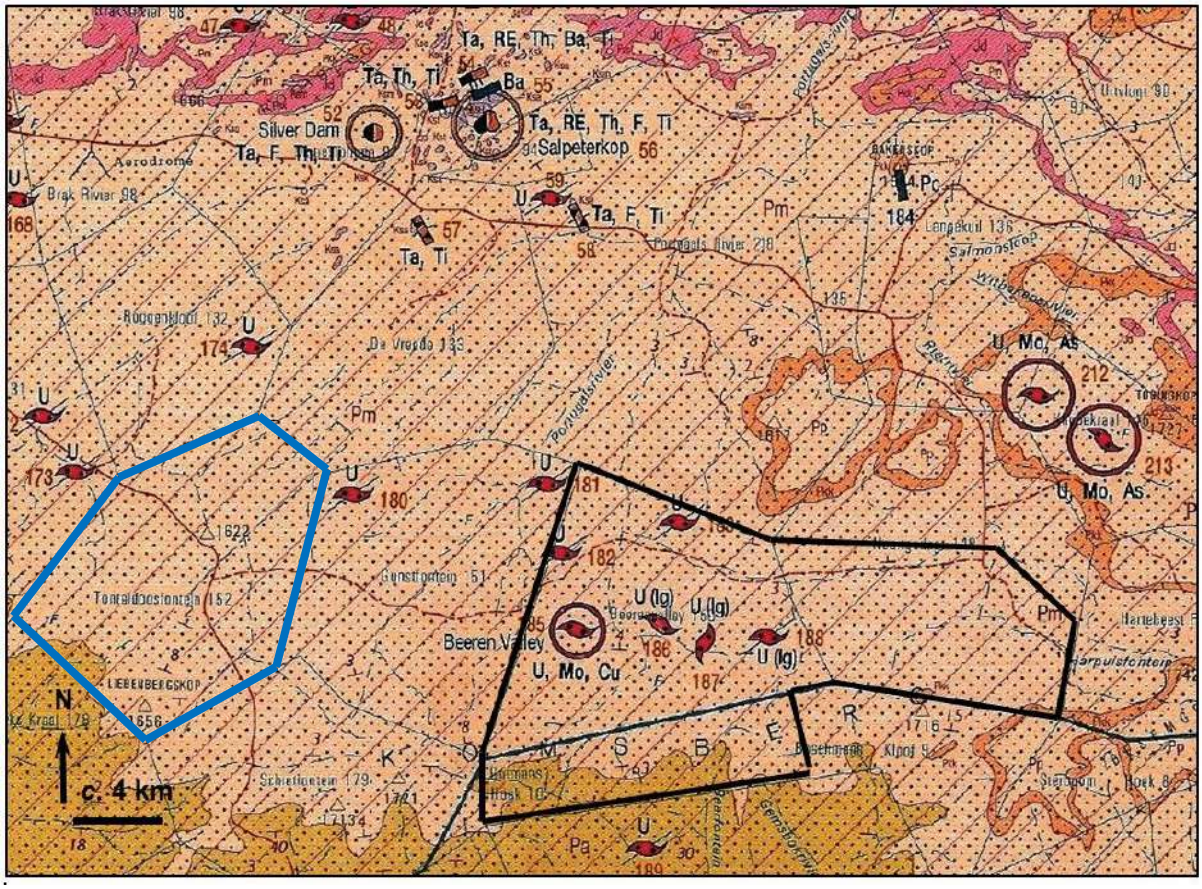

Figure 5: Extract from the 1: 250 000 Sutherland metallogenic map (Cole & Vorster 1999) which differentiates between some of the younger members of the Abrahamskraal and Teekloof Formations in the broader Sutherland Cluster WEF project area (black polygon), *viz*: Moordenaars Member (Pm with stipple, pale orange), Karelskraal Member (Pkk, dark orange with stipple) and Poortjie Member (Pp, pale orange with stipple). Abrahamskraal Formation members below the Moordenaars Member (including the Koornplaats and Swaerskraal Members) are shown undifferentiated in brown. According to the map, the Farm Tonteldoosfontein 152, including the present Sutherland 2 WEF project area, is almost entirely underlain by the Moordenaars Member (blue polygon).

Details of mapped mineral occurrences within the WEF project areas (red symbols, U – uranium, Mo – molybdenum, Cu - copper) are provided by Cole & Vorster (1999). It is noted that, according to the Mineral and Petroleum Resources Development Act, 2002, the company proposing the Sutherland Cluster wind farm developments is required to submit a report from the Council for Geoscience on the mineral potential of the development area to the Department of Mineral Resources (Dr Doug Cole, Council for Geoscience, Bellville, pers. comm. 2015). However, no mineral occurrences are mapped here within the Sutherland 2 WEF project area itself.

Figure 6: Typical low relief, rolling, rocky landscape of the Roggeveld Plateau region as seen in the central sector of Sutherland 2 WEF project area on Farm Tonteldoosfontein 152.

Figure 7: Low relief terrain in the NE sector of the WEF project area, looking north towards the extinct volcano Salpeterkop on the skyline. The incised valley in the middle distance is one of several NE-SW trending, fault-bound valleys in the region that are related to crustal doming during emplacement of the Late Cretaceous Sutherland Suite.

Figure 8: View southwards into the fault-bound valley extending SW of Theronsrus homestead with good exposures of potentially fossiliferous Moordenaars Member overbank mudrocks in the foreground.

Figure 9: Tributary valley of the Portugalsrivier which is traversed by the grid connection corridor just east of Ouplaas homestead on Gunstfontein 151. Several small, potentially fossiliferous mudrock exposures are present along the valley flanks (See Figure 24).

Figure 10: View of the steep Roggeveld Escarpment at Diepgat, just outside the SW corner of the WEF project area. Closely-spaced, tabular sandstone bodies building the Moordenaars Member of the Abrahamskraal Formation dip gently to the SE here and are truncated by a flat-lying erosional land surface of probable Late Cretaceous age.

Figure 11: Good sections through an unusually thick Moordenaars Member channel sandstone package exposed in the steep walls of a side branch of the main fault-bound valley *c*. 1 km ENE of Theronsrus homestead.

Figure 12: Well developed channel breccio-conglomerates within the basal portion of the same sandstone package illustrated above (hammer = 30 cm).

Figure 13: Fallen block from the same locality as above showing an upper grey-green and lower rusty-brown breccio-conglomerate unit (hammer = 30 cm). These coarse sediments contain reworked clasts of mudrock and calcrete glaebules as well as occasional fragments of fossil bone (See Figure 35).

Figure 14: Scabby surface of a major channel sandstone body mantled by platy debris generated by weathering processes such as freeze-thaw, salt crystallisation, thermoclastis / fire-cracking and lichen etching. Fossil remains may occur within channel sandstones but are very sparse, as well as usually fragmentary and disarticulated.

Figure 15: Tabular bedding with planar lamination within a sharp-based channel sandstone body reflecting energetic flood events, seen here in road cuttings through the Moordenaars Member *c*. 600m south of Theronsrus homestead.

Figure 16: Current-ripple cross-lamination seen on a channel sandstone bed top exposed in a shallow stream bed. Such exposures rarely feature vertebrate trackways or other trace fossils.

Figure 17: Extensive, wave-rippled top of a crevasse splay sandstone generated in a shallow pond or lake on the ancient Karoo Basin floodplain (hammer = 30 cm). These surfaces occasionally yield well-preserved tetrapod trackways, fish swimming trails, invertebrate burrows and other trace fossils.

Figure 18: Good riverbank cliff sections through a thick package of purple-brown and grey-green mudrocks of the Moordenaars Member seen *c*. 1 km ENE of Theronsrus homestead.

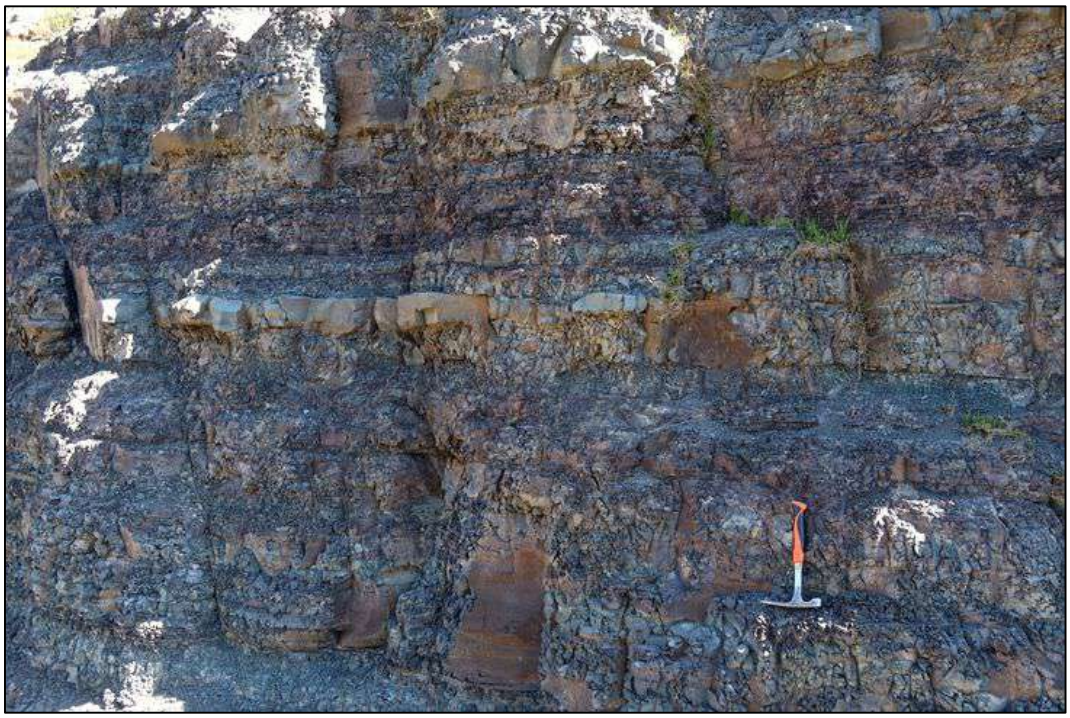

Figure 19: Close-up of the mudrock-dominated succession seen in the previous figure showing tabulate, medium- to thin-bedded, hackly-weathering siltstones with occasional thin, lenticular sandstone interbeds (hammer = 30 cm).

Figure 20: Extensive, gullied hillslope exposures of purple-brown and grey-green Moordenaars Member mudrocks seen c. 750 m WSW of Theronsrus homestead. Such exposures are ideal for recording fossil vertebrates but they appear to be very scarce indeed here.

Figure 21: Well-developed palaeosol (ancient soil) horizons marked by pebble-to cobble-sized palaeocalcrete concretions within the same mudrock package shown above (hammer = 30 cm).

Figure 22: Thin scree of small, greyish palaeocalcrete concretions weathering out of the overbank mudrocks illustrated in the previous two figures. A careful search of such occurrences might well yield small fossil vertebrate remains.

Figure 23: Prominent-weathering lenses of rusty-brown *koffieklip* (ferruginous carbonate) within the mudrock succession, probably diagenetic in origin and associated with periods featuring high water tables.

Figure 24: Occasional good exposures of potentially fossiliferous overbank mudrocks are encountered within or close to the grid connection project area, seen here on Gunstfontein 151 for example. These areas should be surveyed during the proposed pre-construction palaeontological heritage "walkdown".

Figure 25: Marginal apron of large, downwasted sandstone blocks typically associated with channel sandstones in the Roggeveld region (see here in the grid connection project area on Gunstfontein 151). These blocks tend to obscure the underlying mudrocks and basal channel breccias which are of higher palaeontological interest

Figure 26: Small patches of overbank mudrock exposure occur locally along sandstone-capped scarps, as here in the fault-bound valley close to Theronsrus homestead.

Figure 27: Most of the flatter-lying portions of the WEF and grid connection project areas are mantled by sandy soils and surface gravels (mainly wacke, with subordinate siltstone, calcrete concretions) of alluvial or eluvial origin.

Figure 28: Scattered, angular to subrounded blocks of channel wacke overlying greyish to khaki-hued weathered, crumbly and gullied overbank mudrocks of the Moordenaars Member.

Figure 29: Platy clasts of channel wacke accumulated within a shallow pan or *brak-koll*. Such areas may occasionally yield sheet-washed or downwasted blocks of petrified wood but none were recorded within the present study area.

Figure 30: Multi-hued, weathered, crumbly overbank mudrocks of the Moordenaars Member exposed by gulley erosion near the edge of the Roggeveld Escarpment.

Figure 31: Gulley erosion locally exposes sections through unconsolidated gravelly to sandy soils of alluvial and colluvial origin. Well-developed calcrete hardpans were not observed within the project area where older calcretised alluvium is not well represented.

Figure 32: ***In situ*** **weathered sandstone saprolite - perhaps a relic of previous, more humid and pluvial climatic conditions than those prevailing today – leading to the generation of rounded corestones from channel sandstone bodies.**

Figure 33: Boulder-sized, subrounded corestones of channel wacke littering the ***veld*** **within the grid connection project area near Ouplaas homestead on Gunstfontein 151. The rounding of these boulders is a consequence of weathering rather than transport.**

6. PALAEONTOLOGICAL HERITAGE CONTEXT

The palaeontology of the Roggeveld Plateau region in the vicinity of the Sutherland WEF Cluster project area has been outlined with extensive references in recent PIA reports by the author (*e.g.* Almond 2017a, 2019, 2021a-d, 2022). Fossil biotas represented within the project area are referred to the late Middle Permian (Capitanian) ***Tapinocephalus* Assemblage Zone**. The main categories of fossils recorded within the *Tapinocephalus* fossil biozone (Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995a, MacRae 1999, Bamford 1999, Rubidge 1995, 2005, Nicolas 2007, Almond 2010a, Smith *et al.* 2012, Day 2013a, Day 2013b, Day *et al.* 2015b, Marchetti *et al.* 2019, Day & Rubidge 2020) include:

- isolated petrified bones as well as rare articulated, usually partial skeletons of tetrapods (*i.e.* air-breathing terrestrial vertebrates) such as true **reptiles** (notably large herbivorous pareiasaurs like *Bradysaurus*, small insectivorous millerettids, the tortoise-like *Eunotosaurus*), rare pelycosaurs, and diverse **therapsids** or "mammal-like reptiles" (numerous genera of large-bodied herbivorous and carnivorous dinocephalians (*e.g.* predatory anteosaurs, thick-skulled tapinocephalids), herbivorous dicynodonts (mainly small-bodied forms like *Diictodon*), flesh-eating biarmosuchians, rare, small gorgonopsians and a range of insectovous to carnivorous therocephalians, including wolf-sized apex predators of their day);

- aquatic vertebrates such as large, superficially crocodile-like **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish);

- freshwater **bivalves** (*Palaeomutela*);

- **trace fossils** such as tracks and burrows of worms, arthropods, lungfishes and tetrapods, coprolites (fossil droppings), fish swimming trails, and plant stem or root casts;

- **vascular plant remains** (usually sparse and fragmentary), including leaves, twigs, roots and petrified woods ("*Dadoxylon*", now referred to *Australoxylon* and *Prototaxoxylon*) of the *Glossopteris* Flora, especially glossopterid trees and reedy arthrophytes (horsetail ferns) with rare lycopods.

More specifically, the uppermost part of the Abrahamskraal succession - including the Moordenaars Member represented within the present WEF and grid connection project area - is characterised by fossil biotas of the recently defined ***Diictodon – Styracocephalus* Subzone**. This late Middle Permian biozone extends into the lower part of the Poortjie Member and has an estimated age of 262-260 Ma, *i.e.* late Capitanian (Day & Rubidge 2020). Impoverishment of fossil assemblages, notably with few dinocephalians, within the upper part of the subzone *above* the Moordenaars Member are associated with the catastrophic, global end-Capitanian ecological crisis and Mass Extinction Event (*cf* Day *et al.* 2015).

Previous mapping of vertebrate fossil sites within the Main Karoo Basin by Keyser and Smith (1977-1978) as well as Nicolas (2007) indicates that very few sites have been previously recorded within the present study area (Fig. 34). No historical fossil sites are indicated in the Sutherland Cluster WEF project area on the published 1: 250 000 geological map (Fig. 4).

A field-based palaeontological study for the proposed Gunstfontein WEF situated just to the west of the present Sutherland 2 WEF project by Almond (2015g) yielded low-diversity trace fossil assemblages (small-scale invertebrate burrows, plant stem casts) and fragmentary plant fossil remains. The latter include horsetail ferns (arthrophytes), *Glossopteris* leaf impressions as well as concentrations of woody plant material preserved as moulds and blocks of silicified wood. The plant fossils here are often

associated with ferruginised channel sandstones and lag conglomerates (*koffieklip*). Cherty petrified wood clasts are extensively reworked into surface gravels. The only vertebrate fossil remains recorded within the Gunstfontein WEF study area comprised very sparse reworked bones and disarticulated fish scales preserved within ferruginised channel lag conglomerates.

A sparse scatter of fossil sites have been mapped within mudrock facies of the Moordenaars and Karelskraal Members of the Abrahamskraal Formation along the Sutherland WEF Cluster access road from the R354 and on Nooitgedacht Farm 148 by Almond (2017a-b, 2019, 2021a-c). Recently Almond (2022) reported a substantial number of new fossil sites within the Moordenaars Member exposures in the adjoining Sutherland WEF and Rietrug WEF project areas. These Middle Permian fossils comprise weathered-out concentrations of large tetrapod cranial and postcranial material (dinocephalian / pareiasaur), often highly weathered and sun-cracked, rare skulls and post-cranial remains of small dicynodonts, therocephalians and gorgonopsians, unidentifiable disarticulated “rolled bones”, horizons of lungfish burrow casts, several tetrapod burrow casts, low diversity invertebrate burrow assemblages, mostly poorly-preserved fossil wood within ferruginised floodplain pond breccias and impressions of equisetalean ferns. Previous field-based surveys of the project areas Sutherland Cluster 132 kV grid connections and MTS near Merweville By Almond (2017a, 2017b, 2019, 2021d) recorded a limited number of fossil sites within the Abrahamskraal Formation. These include postcranial bones - often fragmentary and poorly preserved - of unidentified large-bodied tetrapods (pareiasaurs / dinocephalians) in surface float and weathering out of basal channel breccias, a large tooth (possibly dinocephalian), invertebrate traces on sandstone palaeosurfaces and within *koffieklip*, ferruginised woody moulds within channel wackes as well as locally abundant but often poorly preserved blocks of silicified wood, especially weathering out from the Koornplaats Member.

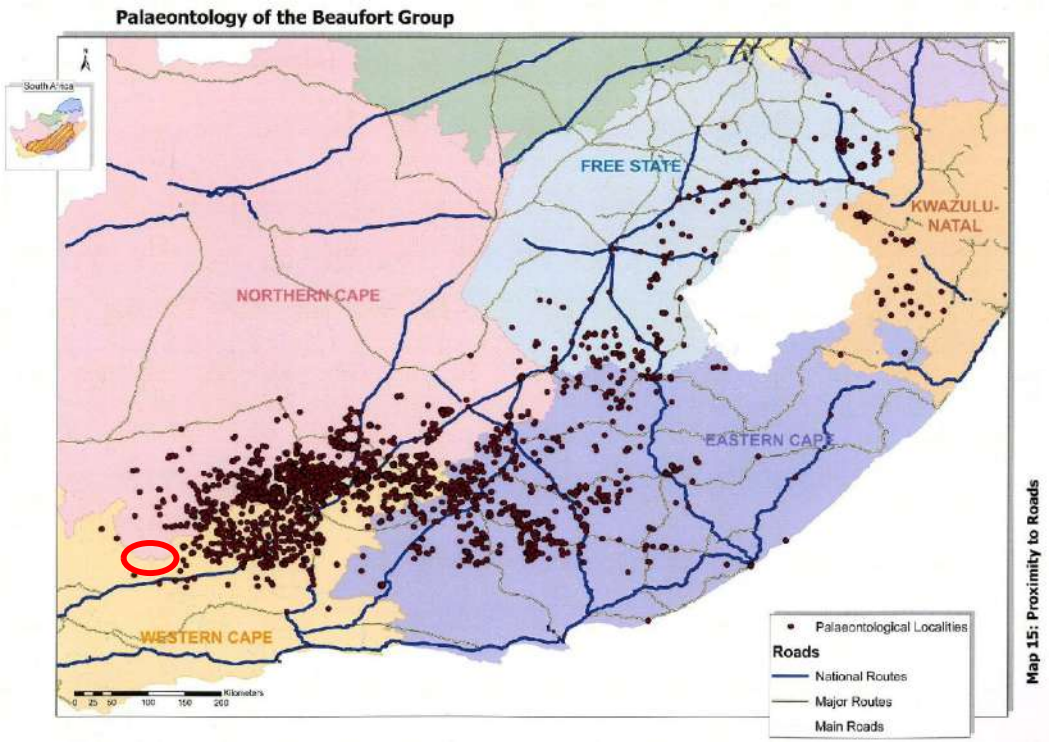

Figure 34: Distribution of recorded vertebrate fossil sites within the Main Karoo Basin (modified from Nicolas 2007). The approximate location of the combined Sutherland 2 WEF project area on the edge of the Roggeveld Escarpment to the southeast of Sutherland is *approximately* indicated by the red ellipse. Note that few vertebrate fossils have been recorded in this area before the recent series of PIA studies for renewable developments, so any new finds recorded here are potentially of scientific interest.

7. NEW PALAEONTOLOGICAL FIELD OBSERVATIONS

The handful of new fossil sites recorded during the recent palaeontological field study of the Sutherland 2 WEF and grid connection project areas are tabulated in Appendix 1, where the sites are also mapped on satellite images in the context of the proposed final layout of the WEF (Fig. A1.1). A representative selection of the new fossil material is illustrated below in Figures 35 to 39, together with explanatory figure legends.

The very few fossil tetrapod fossils recorded from the Moordenaars Member here comprise isolated, fragmentary postcranial remains of one or more unidentified, large-bodied tetrapods (pareiasaur reptile or dinocephalian therapsid) which are associated with ferruginous channel breccias or calcretised pedocrete concretions (Figs. 35 to 37). The scarcity of such fossil remains may be attributable in part to the generally very poor exposure levels of potentially fossiliferous overbank mudrocks within the project area. However, it is noteworthy that even where such exposures are extensive (*cf* Fig. 20) very few or no fossil were found (Another possible factor may be illegal fossil collection which is known to occur in the Sutherland area).

No fossil plant remains have been recorded during the recent field study, although petrified wood and reedy plant stem compressions are known to occur in the nearby Gunsfontein WEF and Sutherland Cluster WEF project areas (Almond 2015g, 2022). Low diversity trace fossil assemblages of simple horizontal burrows and occasional plant stem casts – probably associated with wetland areas - are seen locally on thin-bedded sandstone slabs (Figs. 38 & 39). No fossil material was recorded from the various Late Caenozoic superficial deposits represented within the WEF and grid connection project area. Calcretised plant rootlets occur widely within older alluvial deposits in the Karoo region but are of wide occurrence and limited scientific interest.

Figure 35: Close up of a fallen float block of channel breccio-conglomerates such as illustrated in Figures 12 and 13, here showing isolated fragments of "rolled bone" (arrowed) along the reworked clasts of purple-grey pedocrete concretions and grey-green mudrock (scale in cm) (Loc. 032).

Figure 36: Isolated, suncracked bone fragment of a large tetrapod (pareiasaur or dinocephalian) partially enclosed in pedogenic calcrete, found in surface float (scale in cm) (Loc. 037).

Figure 37: Fragment of the long bone of an unidentified large tetrapod (pareiasaur or dinocephalian) found in float (scale in cm) (Loc. 036).

Figure 38: Sandstone slab with low-diversity, subcylindrical invertebrate burrows preserved as hypichnia and endichnia (scale in half-cm) (Loc. 039).

Figure 39: Sandstone slab with low-diversity, subcylindrical invertebrate burrows preserved as positive hypichnia (scale in cm) (Loc. 039).

8. ASSESSMENT OF IMPACT SIGNIFICANCE

Existing impacts on local palaeontological heritage resources within the Sutherland 2 WEF and associated Grid Connection Infrastructure project areas include (1) background, low-level damage to, or loss of, fossils exposed at the ground surface due to small-stock farming (*e.g.* vehicle activity, irrigation infrastructure, small-scale agriculture) as well as (2) on-going natural weathering and erosion processes that both destroy fossil material as well as expose and prepare-out previously-buried fossils. Loss of fossils though illegal collection is a potentially important, but hopefully minor, factor; however, it is known to have taken place within the Sutherland area recently (*cf* Almond 2022).

The proposed Sutherland 2 WEF and associated Grid Connection Infrastructure developments will entail excavations into the superficial sediment cover (soils, surface gravels, alluvium *etc*) as well as into the underlying, potentially fossiliferous Lower Beaufort Group bedrocks during the construction phase. The developments may adversely affect legally protected and scientifically important fossil heritage within the project footprints by destroying, damaging, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good.

The uppermost Abrahamskraal Formation bedrocks that will be directly impacted by the proposed renewable energy developments belong to parts of the Lower Beaufort Group succession (mainly the Moordenaars Member) that is characterised by common but sparsely distributed fossil sites which may include occasional scientifically important specimens of unpredictable occurrence – most notably fossil vertebrate remains. With the exception of local trace fossil assemblages that are of low scientific or conservation interest, none of the very few fossil sites recorded here is of great scientific value or lies directly within or close to the proposed buildable areas or final footprints of the WEF and associated grid connection projects. This is probably in part due to generally very low levels of exposure of potentially fossiliferous Beaufort Group mudrocks in the region. However, even where mudrock exposure levels are very good here, fossils appear to be very scarce (This has been observed locally in the Sutherland WEF Cluster project area as well by Almond 2022).

The bedrocks within most of the WEF and Grid Connection project footprints are extensively mantled with Late Caenozoic colluvial, eluvial and alluvial deposits and gravely soils that are usually palaeontologically insensitive over most of the Roggeveld Plateau region. Rare fossil mammalian remains might potentially occur within older, calcretised alluvium but none have been recorded here so far.

The significance of overall anticipated impacts on fossil heritage resources within the Sutherland 2 WEF and Grid Connection Infrastructure footprints as a consequence of the proposed renewable energy developments is assessed for the **Construction Phase** in Table 1, both with and without mitigation. This assessment applies to all associated infrastructure, including the wind turbines, laydown areas, internal access road network, operations and maintenance buildings, on-site substation, 132 kV transmission line and service road *etc*. It is concluded that each of the proposed developments will have a NEGATIVE MEDIUM impact significance without mitigation, decreasing to **NEGATIVE LOW following full implementation of the proposed mitigation measures** (See Section 9 and Appendix 2). Negative residual impacts during the construction phase will be partially offset by an improved palaeontological database and fossil collections due to mitigation (*positive* impacts). Despite poor bedrock exposure levels, confidence levels for this assessment are Medium, given the number of field-based palaeontological studies within the wider region.

Once constructed, the **Operational and De-commissioning Phases** of the WEF and grid connection infrastructure developments will not involve further adverse impacts on palaeontological heritage, so these are not assessed here.

In the case of the **No-Go Option** - *i.e.* no Sutherland 2 WEF and grid connection developments - the current processes exerting an impact on local palaeontological heritage, as outlined at the beginning of this section, will continue to operate at low levels. The impact significance of these processes is rated as NEGATIVE LOW (Table 2). They could potentially be mitigated by a programme of professional palaeontological surveys of the development project areas with recording and judicious collection / sampling of scientifically important fossil material.

Table 1: Assessment of overall impacts on fossil heritage resources of the proposed Sutherland 2 WEF and Grid Connection Infrastructure projects - Construction Phase (*Assessment applies equally to both developments*)

Nature: **Disturbance, damage or destruction of legally protected, scientifically valuable fossil heritage resources preserved at or beneath the ground surface through surface clearance and excavations within the project footprint (*e.g.* wind turbine and pylon footings, access road network, laydown areas, on-site substation, building foundations)**		
	Without mitigation	**With mitigation**
Extent	**Low (1)**	**Low (1)**
Duration	**Permanent (5)**	**Permanent (5)**
Magnitude	**Low (4)**	**Minor (2)**
Probability	**Probable (3)**	**Improbable (2)**
Significance	**Medium (30)**	**Low (16)**
Status (positive or negative)	**Negative**	**Negative**
Reversibility	**Low**	**Low**
Irreplaceable loss of resources?	**Possible**	**Unlikely**
Can impacts be mitigated?	**Yes – see below**	
Mitigation: **On-going Construction Phase monitoring for fossils of surface clearance and bedrock excavations by ECO / ESO.** **Application of Chance Fossil Finds Protocol during construction phase with recording and collection of significant new finds by qualified palaeontologist.**		
Residual Impacts: **Small residual impacts may be partially off-set by improved palaeontological database and collections following mitigation.**		

Table 2: Assessment of impacts on fossil heritage resources of the No-Go Option (*i.e.*no development of Sutherland 2 WEF and grid infrastructure)

Nature: **Disturbance, damage or destruction of legally protected, scientifically valuable fossil heritage resources preserved at or beneath the ground surface within project area through small stock farming, natural weathering and erosion, illegal fossil collection.**		
	Without mitigation	**With mitigation**
Extent	**Low (1)**	**n/a**
Duration	**Permanent (5)**	**n/a**
Magnitude	**Minor (2)**	**n/a**
Probability	**Possible (2)**	**n/a**
Significance	**Low (16)**	**n/a**
Status (positive or negative)	**Negative**	**n/a**
Reversibility	**Low**	**n/a**
Irreplaceable loss of resources?	**Possible**	**n/a**
Can impacts be mitigated?	**Yes**	
Mitigation: **Professional palaeontological surveys of project areas with recording and judicious collection / sampling of scientifically important fossil material.**		
Residual Impacts: **n/a**		

- **Cumulative impacts**

As shown by the DFFE Renewable Energy EIA Applications Database (REEA) and the map in Figure 40, a considerable number of renewable energy facilities (notably wind farms) and associated grid connection infrastructure developments have been authorised or proposed for the Roggeveld Plateau and adjoining Klein-Roggeveld regions to the southeast and south of Sutherland. Of these, several have been the subject of combined desktop and field-based palaeontological heritage impact studies (PIAs) by the author and others (See References under Almond). However, only a desktop level PIA has been submitted for the Moyeng Energy Suurplaat WEF to the east (Almond 2010b). Among available palaeontological impact studies for other developments proposed for the region, the most relevant are those on the Roggeveld Plateau for Jakhals Valley solar project (Almond 2011) and the Gunsfontein WEF (Almond 2015g), both located to the south of Sutherland and west of the present study area, as well as the adjoining Sutherland and Rietrug WEFs plus associated grid connections recently assessed by Almond (2022). There are numerous further WEF projects proposed for the Klein-Roggeveld region, below the Great Escarpment and south or southwest of the present study area, but for the most part these concern rocks and fossil assemblages that are older than those encountered in the present WEF study area where the main palaeontological impacts are anticipated; exceptions include the Maralla East and Maralla West WEFs (Almond 2015h, 2015i) as well as the Komsberg West and Komsberg East WEFs (Almond 2015j, 2015k).

Given the extensive outstanding palaeontological heritage field data in the south-eastern Roggeveld region relevant to this development, and following the previous analyses by Almond (2019, 2022), it is *provisionally* concluded that the cumulative impact significance of the proposed Sutherland 2 WEF and associated grid connection developments in the context of renewable energy developments in the region is NEGATIVE MEDIUM without mitigation (Table 3). This would fall to *NEGATIVE LOW provided that* the proposed monitoring and mitigation recommendations made for *all* these various renewable energy projects are consistently and fully implemented (this is unfortunately open to question).

These **anticipated cumulative impacts following full mitigation – including those associated with the Sutherland 2 WEF and Grid Connection Infrastructure projects - lie within acceptable limits**. Unavoidable residual negative impacts may be partially offset by the improved understanding of Karoo palaeontology resulting from appropriate professional mitigation. This is regarded as a *positive* impact for Karoo palaeontological heritage.

Table 3: Assessment of cumulative impacts on fossil heritage resources of the proposed Sutherland 2 WEF and Grid Connection Infrastructure in the context of other comparable renewable energy developments in the region.

Nature: **Disturbance, damage or destruction of legally protected, scientifically valuable fossil heritage resources preserved at or beneath the ground surface through surface clearance and excavations within the project footprint**		
	Without mitigation	**With mitigation**
Extent	**Low (1)**	**Low (1)**
Duration	**Permanent (5)**	**Permanent (5)**
Magnitude	**Moderate (6)**	**Low (4)**
Probability	**Definite (5)**	**Probable (3)**
Significance	**Medium (60)**	**Low (30)**
Status (positive or negative)	**Negative**	**Negative**
Reversibility	**Low**	**Low**
Irreplaceable loss of resources?	**Yes**	**Probably**
Can impacts be mitigated?	**Yes – see below**	
Mitigation: **Specialist palaeontological walk-downs of project footprints in the pre-construction phase in sectors where a full, field-based palaeontological study has yet been conducted.** **On-going Construction Phase monitoring for fossils of surface clearance and excavations by ECO / ESO.** **Application of Chance Fossil Finds Protocol during construction phase with recording and collection of significant new finds by qualified palaeontologist.**		
Residual Impacts: **Residual impacts may be partially off-set by improved palaeontological database following mitigation.**		

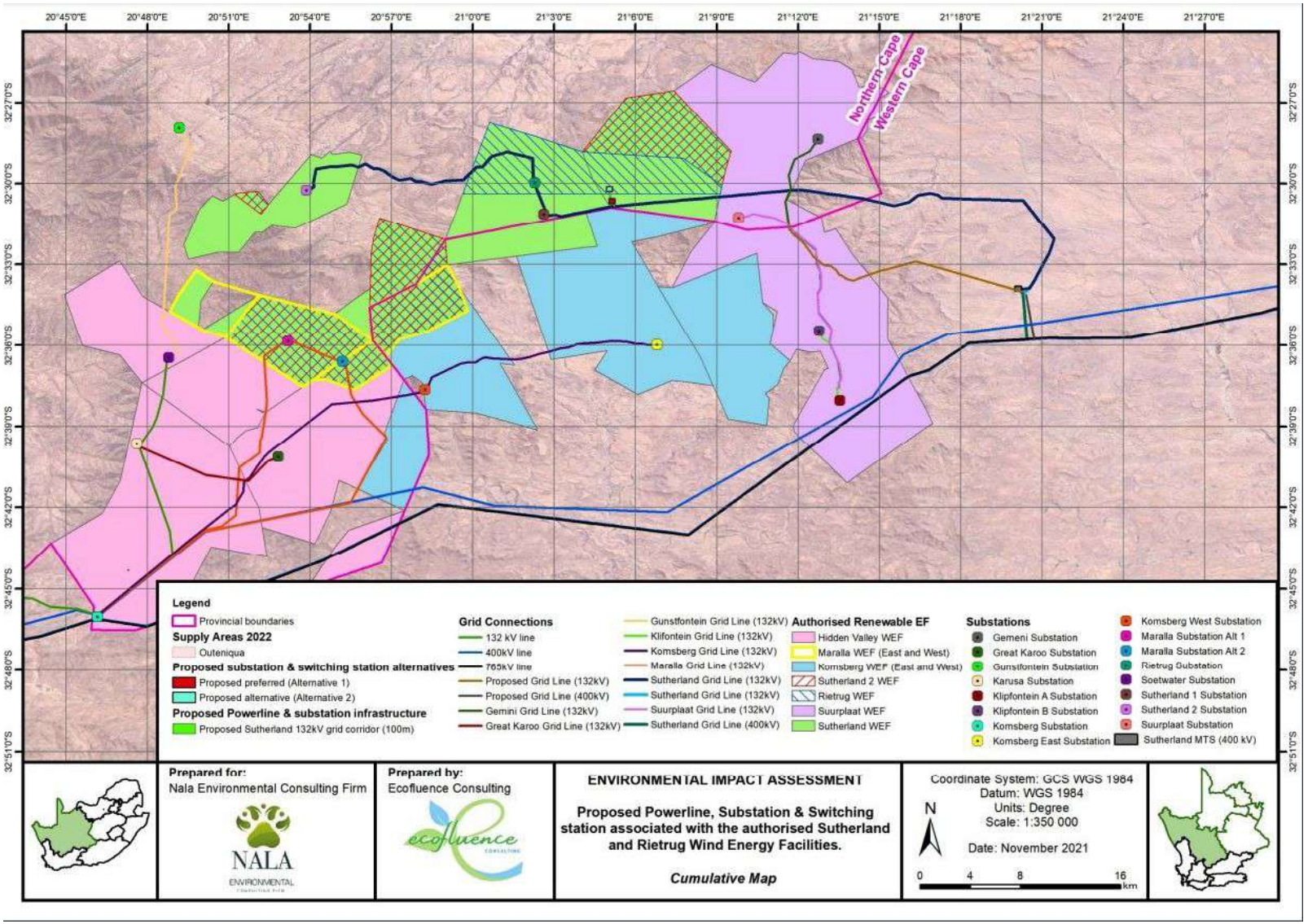

Figure 40: Map showing the large number of authorised or proposed WEF and grid infrastructure projects in the vicinity of the Mainstream Sutherland 2 WEF and associated Grid Connection Infrastructure projects.

9. CONCLUSIONS & INPUT INTO EMPrs

The following conclusions and recommendations - for inclusion in the relevant Environmental Management Programme (EMPr) - apply to the Sutherland 2 WEF and its accompanying Grid Connection Infrastructure project (including the new on-site substation).

The relevant Provincial Heritage Resources Agencies for these renewable energy developments is SAHRA for the Northern Cape (Contact details: Heritage Western Cape. 3rd Floor Protea Assurance Building, 142 Longmarket Street, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 021 483 5959 Email: ceoheritage@westerncape.gov.za. SAHRA: 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za).

Desktop studies - including provisional palaeosensitivity mapping by SAHRIS and the DFFE - as well as several successive palaeontological site visits to the wider region indicate that the Sutherland 2 WEF and Grid Connection Infrastructure project areas are potentially of HIGH palaeosensitivity. However *scientifically valuable, conservation-worthy* fossil remains have a very sparse and largely unpredictable distribution here. All of the recorded fossils here hitherto are of limited scientific or conservation value (see Provisional Field Rating tabulated in Appendix 1 as well as previous PIA reports by Almond in the References) while no significant fossil sites lie within or close to (< 20 m) the relevant development footprints (see satellite map in Appendix 1, Fig. A1.1).

Anticipated impacts on fossil heritage resources of each of the proposed renewable energy developments in the **Construction Phase** will have a NEGATIVE MEDIUM significance without mitigation, decreasing to NEGATIVE LOW following full implementation of the proposed mitigation measures (See Section 8). Negative residual impacts during the construction phase will be partially offset by an improved palaeontological database and fossil collections due to mitigation (*positive* impacts). Confidence levels for this assessment are Medium, given the number of previous field-based PIA studies in the broader project area. Once constructed, the **Operational and De-commissioning Phases** of the WEF and grid connection infrastructure developments will not involve further adverse impacts on palaeontological heritage, so these are not assessed here.

The cumulative impact significance of each of the proposed WEF and grid connection projects in the context of other proposed or authorised renewable energy developments in the region is NEGATIVE MEDIUM without mitigation. This would fall to *NEGATIVE LOW provided that* the proposed monitoring and mitigation recommendations made for *all* these various renewable energy projects are consistently and fully implemented. The anticipated cumulative impacts fall within acceptable limits.

For these reasons, there are no palaeontological heritage reservations concerning the proposed final layouts for the Sutherland 2 WEF and associated Grid Connection Infrastructure (including the on-site substation) (*i.e.* layouts are acceptable from palaeontological perspective) and no mitigation regarding the recorded fossil sites - including micro-siting of the proposed final layouts – is recommended here.

- **Input into the EMPrs**

Given the very large project areas concerned, the substantial number of fossil sites now recorded in the wider region as well as the inherent unpredictability of these sites, the potential occurrence of additional *unrecorded* sites of scientific and conservation value at or beneath the ground surface within the WEF and grid connection development footprints cannot be completely excluded.

It is therefore recommended that:

(1) The final authorised layouts of the WEF and its associated Grid Connection Infrastructure should be cross-checked against the known available palaeontological database. Residual, potentially sensitive, un-surveyed sectors of the western sector of the grid connection footprint – notably *those* between the Sutherland 2 WEF on-site substation and Sutherland / Rietrug WEF on-site substations - may need to be surveyed prior to the commencement of clearing activities by a professional palaeontologist, with recording and judicious sampling or collection of any scientifically valuable fossil material.

(2) New fossil material encountered or exposed during the Construction Phase is best handled through the Chance Fossil Finds Protocol outlined in Appendix 2. This tabulated protocol should be incorporated into the EMPr for each development and fully implemented by the responsible Environmental Control Officer (ECO) / Environmental Site Officer (ESO).

The ECO / ESO responsible for the WEF and Grid Connection Infrastructure developments should be made aware of the possibility of important fossil remains (vertebrate bones, teeth and burrows, petrified wood, plant-rich horizons *etc.*) being found or unearthed during the construction phase of the projects. Monitoring for fossil material of all major surface clearance (including access roads) and deeper (>1m) excavations by the ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds should be safeguarded, preferably *in situ*, and reported at the earliest opportunity to SAHRA for recording and sampling by a professional palaeontologist. If triggered, these mitigation actions to conserve legally-protected fossil heritage are considered to be essential.

(3) The palaeontologist will be required to apply for a Fossil Collection Permit from SAHRA for professional mitigation in the Northern Cape. All fieldwork and reporting should meet the standards of international best practice as well as those developed for PIA reports by SAHRA (2013). Fossil material collected must be safeguarded and curated within an approved palaeontological repository (*e.g.* museum or university collection) with full collection data.

It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

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12. JOHN ALMOND SHORT CV

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and the University of Tübingen in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa and Madagascar. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out numerous palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest Province, Mpumalanga, Gauteng, KwaZulu-Natal and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as a member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
Palaeontologist
***Natura Viva* cc**

APPENDIX 1: NEW PALAEONTOLOGICAL SITE DATA

GPS readings were taken in the field using a hand-held Garmin GPSmap 62sc instrument (pre-2022) or GPSmap 62s instrument (2022). The datum used is WGS 84.

Newly recorded fossil sites are mapped in the context of the proposed buildable areas for the Sutherland 2 Wind Energy Facility and associated Grid Connection Infrastructure on the satellite image in Figures A1.1 and A1.2 below. The fossil sites tabulated and mapped here obviously do not (and cannot) represent *all* fossil sites at surface within the very extensive Karoo project areas but, at most, a representative sample of these. Therefore the absence of recorded fossil sites in a particular area does *not* mean that fossils are not present here at surface or in the subsurface. For this reason, a Chance Fossil Finds Protocol is appended to this report.

Fossil data tables for the Grid Connection corridor between the Sutherland Cluster WEFs project area and the proposed new MTS site near Merweville have been tabulated and mapped by Almond (2022, Tables A2 and A3 therein) and this data are therefore not repeated here.

Note that locality data for South African fossil sites in not for public release due to conservation concerns.

Table A1. Fossil site data for Sutherland 2 WEF and western grid connection project areas (September 2022)

Loc.	GPS data	Comments
032	32.603364°S 20.762690°E	Portion 1 of Tonteldoosfontein 152. Moordenaars Member (Abrahamskraal Formation). Channel breccio-conglomerate lenses with sparse scatter of unidentifiable “rolled bone” fragments, both in situ and within fallen blocks. Proposed Field Rating IIIC. No mitigation recommended (outside WEF project area).
036	32.605749°S 20.750283°E	Portion 1 of Tonteldoosfontein 152. Moordenaars Member (Abrahamskraal Formation). Fragment of the long bone of an unidentified large tetrapod (pareiasaur or dinocephalian) found in float. Proposed Field Rating IIIB. No mitigation recommended (outside WEF project area).
037	32.605967°S 20.750548°E	Portion 1 of Tonteldoosfontein 152. Moordenaars Member (Abrahamskraal Formation). Isolated, suncracked bone fragment of a large tetrapod (pareiasaur or dinocephalian) partially enclosed in pedogenic calcrete, found in surface float. Proposed Field Rating IIIB. No mitigation recommended (outside WEF project area).
039	32.608841°S 20.778346°E	Portion 1 of Tonteldoosfontein 152. Moordenaars Member (Abrahamskraal Formation). Several sandstone slabs with low-diversity, subcylindrical invertebrate burrows preserved as hypichnia and endichnia. Proposed Field Rating IIIC. No mitigation recommended (close to grid connection corridor but low scientific / conservation significance).

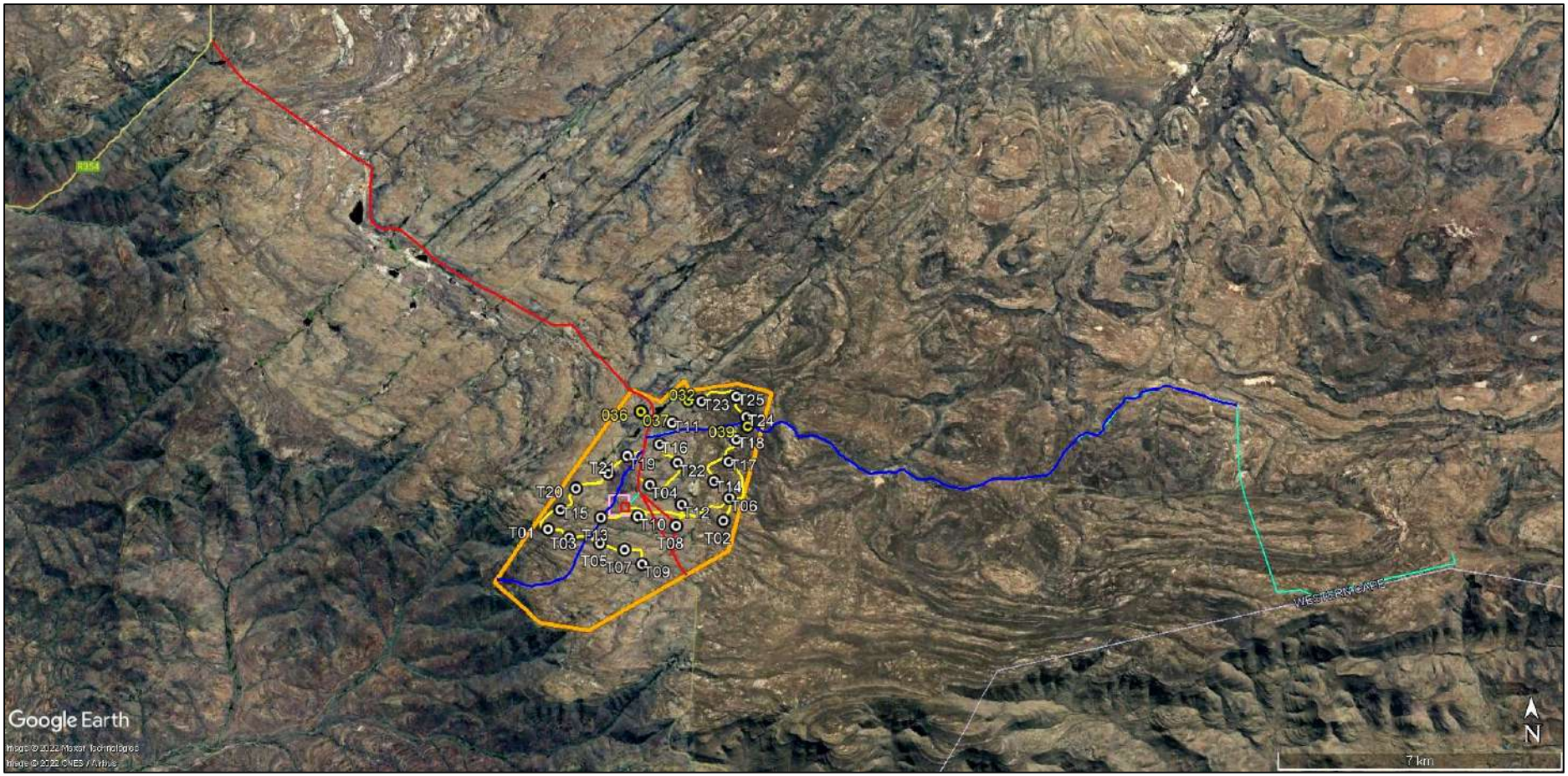

Figure A1.1: Google Earth© satellite image showing the outline of the Sutherland 2 WEF project area (orange polygon), Grid Connection (blue and green lines) and access roads (red lines). The dark blue sector of the Grid Connection lies within the servitude of an existing unpaved road. Please see following figure for more detail of the WEF project area.

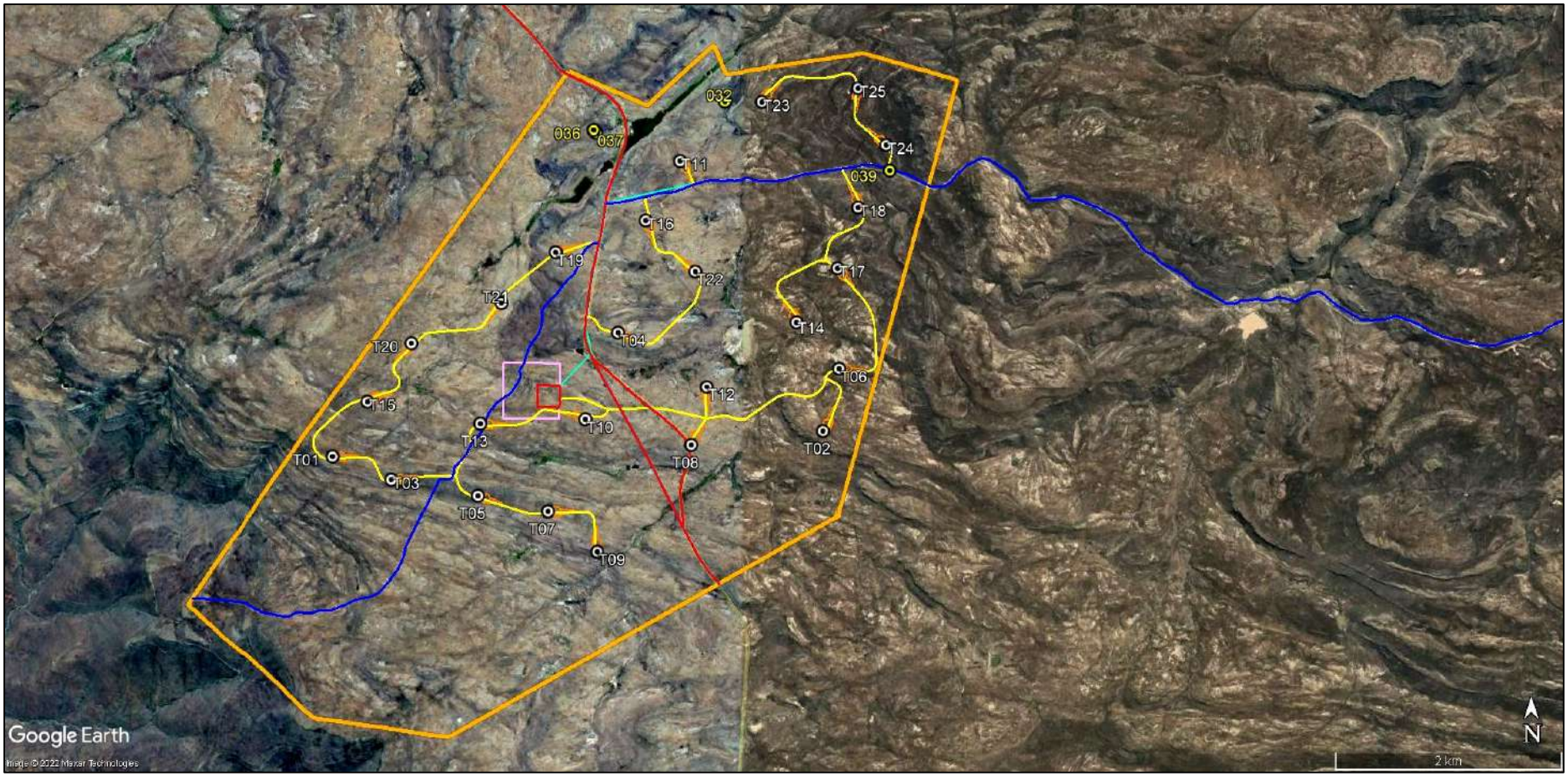

Figure A1.2: Google Earth© satellite image showing the outline of the Sutherland 2 WEF project area (orange polygon), the western sector of the Grid Connection (blue line) as well as external and internal access roads (red lines). The on-site substation is indicated by the pink rectangle and wind turbine locations by numbered white circles. Recently recorded fossil sites are shown by the numbered yellow circles. With the exception of low-significance trace fossils at Loc. 039, none of the fossil sites lies within or close to (< 20 m) the proposed WEF and grid connection footprints and therefore no mitigation is recommended with regard to these sites.

<table>
<tr><th colspan="3">APPENDIX 2: CHANCE FOSSIL FINDS PROCEDURE: Authorised Sutherland 2 Wind Energy Facility and associated Grid Connection Infrastructure, Northern Cape Province</th></tr>
<tr><td>Province & region:</td><td colspan="2">Northern Cape (Namaqua District)</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa.
Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup)
Late Caenozoic alluvium along water courses</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Petrified wood and other plant remains, skeletal remains of tetrapods (e.g. therapsids), trace fossils of invertebrates and vertebrates (fish / tetrapod burrows, trails & trackways) in Abrahamskraal Formation bedrocks.
Bones, teeth and horn cores of mammals, freshwater molluscs, calcretised termitaria and other trace fossils in older consolidated alluvium.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
Context – describe position of fossils within stratigraphy (rock layering), depth below surface
Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Authority</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.</td></tr>
</table>